The relationship between the Driver Behavior Questionnaire, Sensation Seeking Scale, and recorded crashes: A brief comment on Martinussen et al. (2017) and new data from SHRP2

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The recently published paper by Martinussen et al. (2017) is a unique large-sample study (N = 3,683) on the relationship between the Driver Behavior Questionnaire (DBQ) and recorded violations and crashes.

There are two important findings. First, the authors found that 22.4% of participants who were classified into the 'violating unsafe drivers' group (based on a cluster analysis of self-reported answers to the DBQ and Driver Skill Inventory, DSI) were involved in a recorded traffic law offence. This percentage is 2.8 times as high as the average of the other three groups ('skilled safe drivers, 'unskilled safe drivers', and 'low confidence safe drivers'). This finding is consistent with a meta-analysis which showed that a moderate correlation (r = 0.24) exists between the DBQ violations score and recorded measures of speed/speeding (De Winter et al., 2015).

Second, the authors found that the four groups did not differ in recorded crash rates. It is important to emphasize, however, that only 1.1% of the participants were involved in a crash (despite the 6-year recording period). This low percentage means that the 'violating unsafe drivers' group contained only 6 or 7 crash-involved drivers (estimated from sample sizes reported in Martinussen et al., 2014). Considering that traffic violations correlate with crashes (Cooper, 1997; Factor, 2014) and young males are overinvolved in crashes (OECD, 2006), it would be inappropriate for one to conclude from their data that the 'violating unsafe drivers' group (consisting of 74% males with a mean age of 39 years) is equally safe as the other three groups (consisting overall of 47% males with a mean age of 54 years). With simulations, De Winter et al. (2015) showed that if crash rates are low, then correlations with crash involvement are necessarily small (see also Af Wåhlberg & Dorn, 2009).

Here, we report on DBQ-crash correlations in a newly accessed dataset from the Strategic Highway Research Program (SHRP2) naturalistic driving study (Dingus et al., 2015). The dataset comprised 3,215 drivers. We removed drivers with less than 7 months of participation and drivers who drove less than 100 miles, leaving data for 2,790 drivers. The mean study length across drivers was 1.31 years (SD = 0.51 years). In case no more than two DBQ items were missing for a driver, then the scores for these items were replaced with the value from the single 'nearest neighbor' variable (1NN); otherwise, the DBQ data for that driver were discarded. Accordingly, DBQ data were available for 2,737 drivers. Participants' scores for the Sensation Seeking Scale Form V (SSS) were retrieved as well (N = 2,781). Whether the DBQ and SSS correlate with recorded crashes has been a much-debated topic (e.g., Af Wåhlberg, 2010; De Winter et al., 2015).

First, we applied principal component analysis on the 24-item DBQ. Inspection of the scree plot (see supplementary material, Figure S1) suggested that a three-component solution was appropriate. The three components were obliquely rotated (Promax) and interpreted as (1) slips, (2) violations, and (3) lapses (see Table S1 for loadings). Component scores were calculated using the regression method. Next, Spearman rank-order correlations were computed between the self-report scores (DBQ scores and SSS score) on the one hand, and relevant study variables (age, gender, crash involvement, driving style) on the other (Table 1).

The results in Table 1 confirm the well-known phenomenon that older drivers report fewer violations than younger drivers and that females report fewer violations but more errors than males. It is also found that DBQ errors and DBQ violations correlate with self-reported crashes in the past three years, and with objective crashes and near-crashes during the naturalistic driving study period. These correlations were overall small yet mostly statistically significant. The correlations were stronger for DBQ violations and SSS than for DBQ slips and lapses. For crashes of the highest severity level (airbag, injury, rollover), the correlation with DBQ violations was small ($\rho = 0.02$). Only 3% of drivers were involved in this type of crash. For all crashes, the correlation with DBQ violations was somewhat stronger ($\rho = 0.06$), and for near-crashes, the correlation with DBQ violations was moderate ($\rho = 0.20$). These findings support the previous assertion that correlations are smaller if the mean (and therefore the variance) of the number of crashes is higher (Af Wåhlberg & Dorn, 2009; De Winter et al., 2015).

Table 1 also shows that the DBQ violations score was associated with a more adverse driving style (hard starts, stops, and turns), with correlations between 0.04 and 0.24. Finally, it can be observed that the pattern of correlations for the SSS was similar to that for DBQ violations (Table 1; Figure S2). This is also reflected in the fact that the DBQ violations score was associated with the SSS score ($\rho = 0.36$), whereas the correlations between the SSS and DBQ slips and DBQ lapses were smaller ($\rho = 0.09$ and $\rho = 0.10$, respectively).

Table 1
Spearman rank-order correlations between Driver Behavior Questionnaire (DBQ) scores, Sensation Seeking Scale (SSS) scores, and study variables.

Study variable	*M*	*SD*	ρ DBQ slips	ρ DBQ violations	ρ DBQ lapses	ρ SSS
Age group (1 = 16–19 years, 17 = 95–99 years)	6.1113	4.679	0.00	-0.33*	-0.10*	-0.43*
Gender (0 = male, 1 = female)	0.5219	0.4996	0.07*	-0.06*	0.19*	-0.15*
Distance driven in study period (miles)	10371.74	7283.22	0.04	0.18*	0.03	0.11*
Number of self-reported crashes in past 3 years (0, 1, 2+)	0.319	0.5815	0.10*	0.13*	0.09*	0.10*
Number of recorded crashes in study period	0.605	1.1488	0.04* (0.04)	0.06* (0.04*)	0.05* (0.05*)	0.10* (0.09)
Number of recorded near-crashes in study period	2.1846	3.35	0.04* (0.03)	0.20* (0.15*)	0.03 (0.02)	0.20* (0.18*)
Number of recorded at-fault crashes in study period	0.4989	1.0664	0.05* (0.04*)	0.05* (0.03)	0.05* (0.05*)	0.10* (0.09*)
Number of recorded at-fault near-crashes in study period	1.2885	2.3802	0.05* (0.04)	0.18* (0.15*)	0.02 (0.02)	0.20* (0.18*)
Number of recorded severity 1 crashes in study period	0.0333	0.1835	0.00 (0.00)	0.02 (0.02)	0.00 (0.00)	0.02 (0.02)
Number of recorded severity 2 crashes in study period	0.0656	0.2711	0.02 (0.02)	0.06* (0.06*)	-0.01 (-0.01)	0.05* (0.05*)
Number of hard starts per mile in a 6-month period	0.0458	0.0786	-0.02	0.07*	-0.01	0.10*
Number of hard stops per mile in a 6-month period	0.1312	0.1384	0.03	0.04*	0.04*	0.08*
Number of hard left turns per mile in a 6-month period	0.1665	0.1457	-0.03	0.21*	0.01	0.27*
Number of hard right turns per mile in a 6-month period	0.1629	0.1341	-0.03	0.24*	0.02	0.27*

Note. * $p < .05$. Correlations for the number of crashes per mile are reported in parentheses. Severity 1 crashes are defined as airbag/injury/rollover, high delta-V crashes (virtually all would be police reported). Severity 2 crashes are defined as police-reportable crashes (including police-reported crashes, as well as others of similar severity which were not reported) (Dingus et al., 2015). Hard starts, stops, and turns are defined as incidences where the acceleration exceeded 0.30 g (Jun et al., 2007). The sample sizes per cell are reported in the supplementary materials (Table S2).

Finally, although many of the correlations shown in Table 1 are statistically significant and theoretically interesting, we wish to caution that they are not necessarily practically significant. A boxplot of the SSS scores for non-crash-involved drivers and crash-involved drivers (Fig. 1, top) shows that there is a high degree of overlap of the SSS distributions of both groups, even though the difference was strongly significant, $t(2779) = 5.55$, $p = 3.07*10^{-8}$, Cohen's $d = 0.22$. For near-crashes, the effect was somewhat stronger (Fig. 1, bottom), $t(2779) = 8.77$, $p = 2.97*10^{-18}$, Cohen's $d = 0.35$.

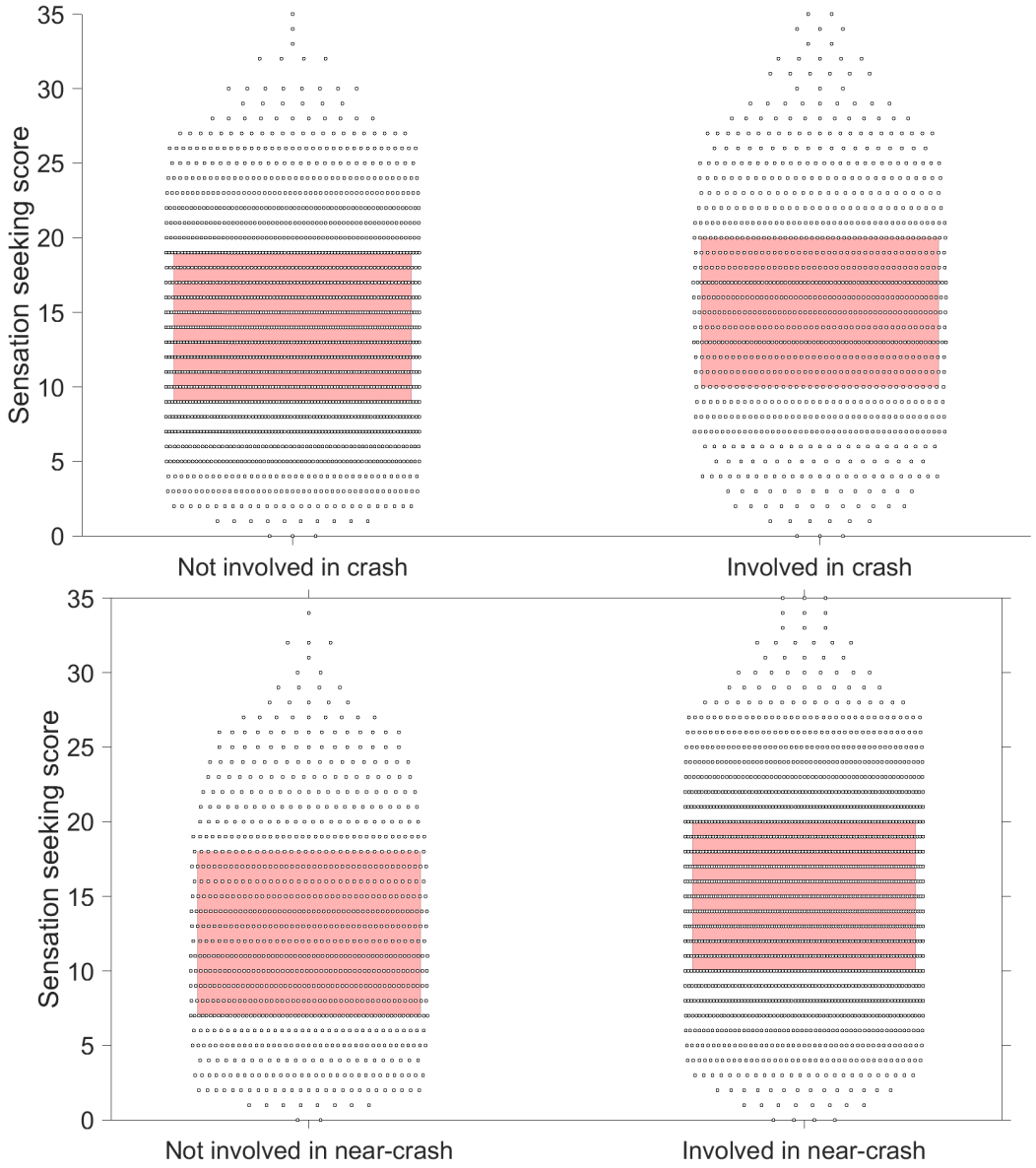

Figure 1. Top: Sensation Seeking Scale scores for drivers who are not involved in a crash (N = 1,766) and drivers who are involved in a crash (N = 1,015). Bottom: Sensation Seeking Scale scores for drivers who are not involved in a near-crash (N = 917) and drivers who are involved in a near-crash (N = 1,864). The red box shows the 25th and 75th percentiles, respectively. The markers represent the individual drives.

In conclusion, we support the findings and interpretations by Martinussen et al. (2017) and hope that the above points are a useful addendum. It appears that DBQ violations, as well as the SSS, exhibit small associations with crash involvement, and small to moderate associations with near-crash involvement and driving style. The predictive validity of DBQ errors (slips and lapses) appears to be weak. Future research should examine the validity of near-crashes as a proxy for crashes.

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Supplementary material

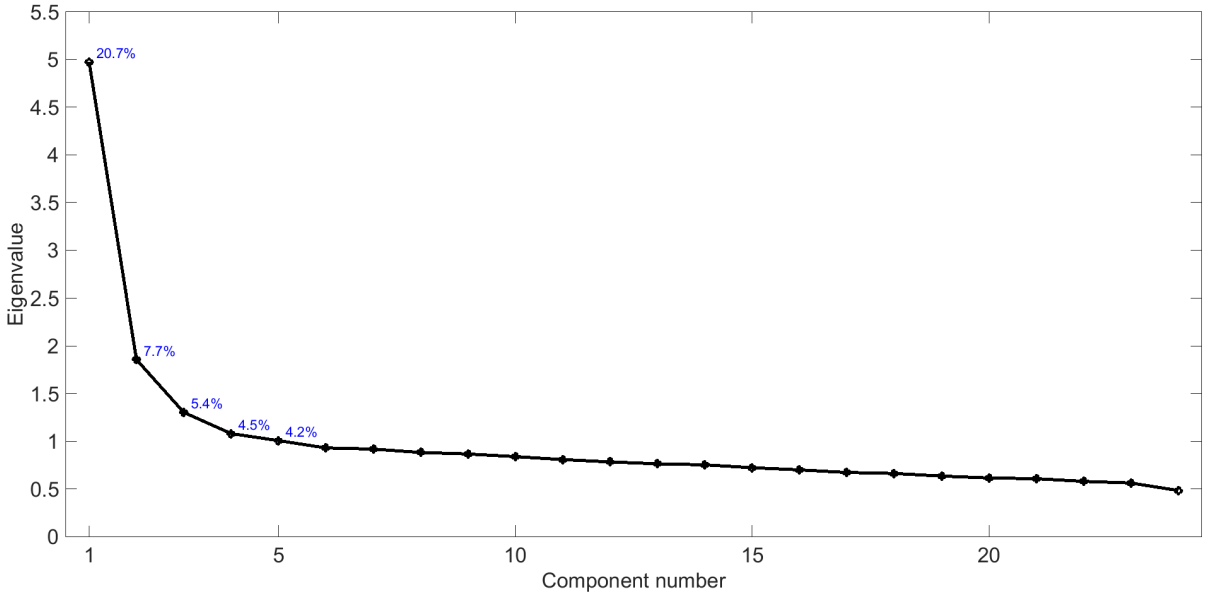

Figure S1. Eigenvalues of the correlation matrix of the 24 items of the Driver Behavior Questionnaire (DBQ), sorted in descending order ('scree plot'). Also shown are the percentages of variance explained (being proportional to the eigenvalue) for the first five components prior to rotation.

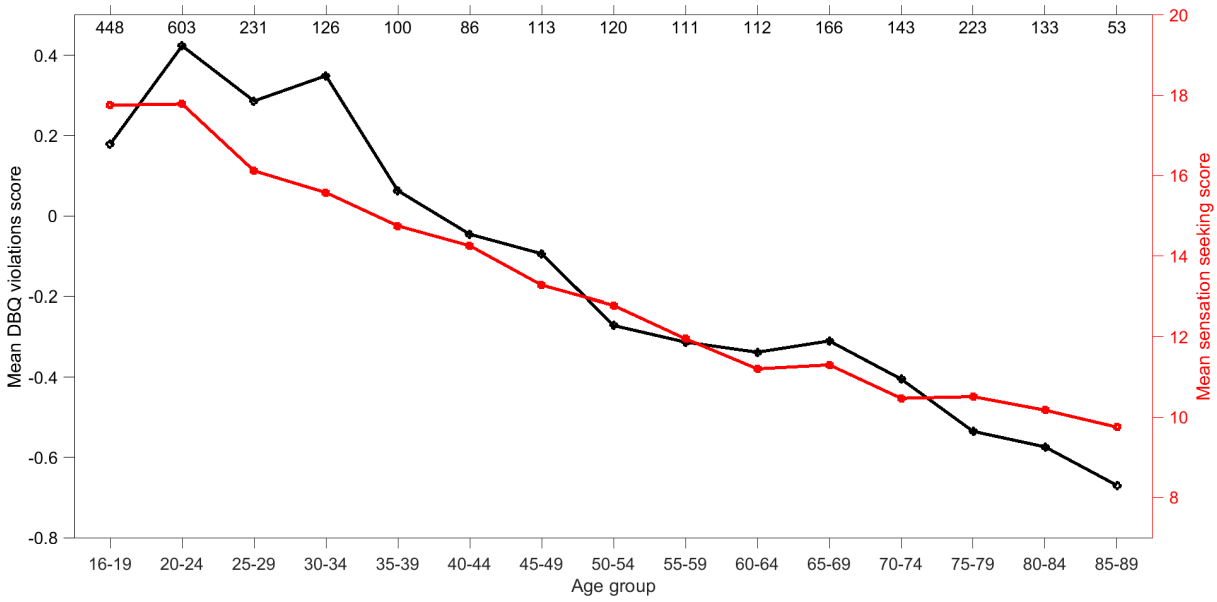

Figure S2. Mean Driver Behavior Questionnaire (DBQ) violations score and mean Sensation Seeking Scale score per age group. The sample sizes per age group are shown at the top of the figure. Results for 90–94 years and 95–99 years are not shown because of small sample size (n = 6 and 2, respectively). The age group was not known for 14 of 2,790 drivers.

Table S1. *Principal component loadings of 24 Driver Behavior Questionnaire (DBQ) items, for the first three components after Promax rotation.*

#	DBQ item	DBQ slips	DBQ violations	DBQ lapses
1	Attempt to drive away from traffic lights in the wrong gear	0.05	0.11	0.18
2	Become impatient with a slow driver in the fast lane and pass on the right	-0.25	0.74	0.21
3	Drive especially close to a car in front as a signal to the driver to go faster or get out of the way	-0.20	0.79	0.11
4	Attempt to pass someone that you hadn't noticed to be making a left turn	0.15	0.43	0.09
5	Forget where you left your car in a parking lot	-0.01	-0.04	0.65
6	Turn on one thing, such as your headlights, when you mean to switch on something else, such as the windshield wipers	0.26	-0.10	0.45
7	Realize that you have no clear recollection of the road along which you have just been traveling	-0.15	0.22	0.66
8	Cross an intersection knowing that the traffic lights have already changed from yellow to red	0.05	0.39	0.28
9	Fail to notice that pedestrians are crossing when turning onto a side street from a main road	0.49	0.03	0.18
10	Angered by another driver's behavior, you catch up to them with the intention of giving him/her "a piece of your mind."	0.27	0.51	-0.26
11	Misread the signs and turn the wrong direction on a one-way street	0.51	-0.16	0.19
12	Disregard the speed limits late at night or early in the morning	-0.09	0.62	0.19
13	When turning right, nearly hit a bicyclist who is riding along side of you	0.72	-0.06	-0.30
14	Attempting to turn onto a main road, you pay such close attention to traffic on the road you are entering that you nearly hit the car in front of you that is also waiting to turn.	0.48	0.03	0.12
15	Drive even though you realize you might be over the legal blood alcohol limit	0.01	0.36	-0.03
16	Have an aversion to a particular class of road user, and indicate your hostility by whatever means you can	0.37	0.38	-0.33
17	Underestimate the speed of an oncoming vehicle when attempting to pass a vehicle in your own lane	0.49	0.08	0.07
18	Hit something when backing up that you had not previously seen	0.52	-0.18	0.09
19	Intending to drive to destination A, you 'wake up' to find yourself on a road to destination B, perhaps because destination B is a more common destination.	0.06	0.05	0.57
20	Get into the wrong lane approaching an intersection	0.25	-0.06	0.42
21	Miss "Yield" signs, and narrowly avoid colliding with traffic having the right of way	0.73	-0.12	-0.01
22	Fail to check your rearview mirror before pulling out, changing lanes, etc.	0.31	0.11	0.17
23	Get involved in unofficial 'races' with other drivers	0.10	0.49	-0.15
24	Brake to quickly on a slippery road or steer the wrong way into a skid	0.45	0.01	0.12

Table S2. *Sample sizes for each of the variables, and for each pair of variables.*

Study variable		DBQ slips	DBQ violations	DBQ lapses	SSS
	N	**2,737**	**2,737**	**2,737**	**2,781**
Age group (1 = 16–19 years, 17 = 95–99 years)	**2,776**	2,723	2,723	2,723	2,767
Gender (0 = male, 1 = female)	**2,790**	2,737	2,737	2,737	2,781
Distance driven in study period (miles)	**2,790**	2,737	2,737	2,737	2,781
Number of self-reported crashes in past 3 years (0, 1, 2+)	**2,781**	2,731	2,731	2,731	2,772
Number of recorded crashes in study period	**2,790**	2,737	2,737	2,737	2,781
Number of recorded near-crashes in study period	**2,790**	2,737	2,737	2,737	2,781
Number of recorded at-fault crashes in study period	**2,790**	2,737	2,737	2,737	2,781
Number of recorded at-fault near-crashes in study period	**2,790**	2,737	2,737	2,737	2,781
Number of recorded severity 1 crashes in study period	**2,790**	2,737	2,737	2,737	2,781
Number of recorded severity 2 crashes in study period	**2,790**	2,737	2,737	2,737	2,781
Number of hard starts per mile in a 6-month period	**2,779**	2,726	2,726	2,726	2,770
Number of hard stops per mile in a 6-month period	**2,779**	2,726	2,726	2,726	2,770
Number of hard left turns per mile in a 6-month period	**2,779**	2,726	2,726	2,726	2,770
Number of hard right turns per mile in a 6-month period	**2,779**	2,726	2,726	2,726	2,770

Note. DBQ = Driver Behavior Questionnaire, SSS = Sensation Seeking Scale.